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Hemodialysis vascular access preferences and outcomes in the Dialysis Outcomes and Practice Patterns Study (DOPPS)

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Background. Synthetic grafts have generally been found to exhibit lower survival rates and higher complication rates than native arteriovenous fistulae. We investigated whether survival of grafts relative to fistulae was better in facilities with a preference for grafts, hypothesizing that such facilities may place more grafts because grafts produced superior outcomes.

Methods. The study was based on a national U.S. sample of 133 hemodialysis facilities participating in the Dialysis Outcomes and Practice Patterns Study (DOPPS), a prospective, observational study of dialysis treatment practices and outcomes. Vascular access preferences were ascertained from medical directors, nurse managers, and actual practice within each facility (% graft use among prevalent patients). Logistic regression was used to model the odds ratio (OR) of graft placement (vs. fistula) and Cox regression was used to model time from access creation to initial failure.

Results. Grafts were preferred by 21% of medical directors and 40% of nurse managers. Patients in facilities in which the medical director or nurse manager expressed a preference for grafts were more than twice as likely to have a graft than a fistula (AOR = 2.3, $P < 0.01$; reference group = facilities that did not prefer grafts), suggesting that facility preferences influence the type of access created. Overall, grafts were more prevalent than fistulae in dialysis facilities, but displayed a higher relative risk of failure (RR 1.33, $P < 0.0001$). However, the risk of graft versus fistula failure did not vary by expressed preference of the medical director: the relative risk of graft versus fistula failure was 1.39 in facilities in which the medical director preferred grafts and 1.39 in facilities in which the medical director preferred fistulae. Moreover, the relative risk of graft versus fistula failure was 1.57 in facilities that used more than the median percentage of grafts and 1.19 in facilities that used less than the median percentage of grafts.

Conclusions. No evidence was found that graft outcomes are superior in facilities that prefer grafts to fistulae. The observed variation in vascular access practice patterns suggests opportunities for quality improvement if optimal practices can be defined.

Key words: hemodialysis, vascular access, arteriovenous fistula, synthetic graft, patient outcomes, practice patterns.

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Hemodialysis vascular access procedures entail large morbidity and cost [1, 2], making them an attractive target for quality improvement and resource savings. Large variation in the use of synthetic bridge grafts versus native arteriovenous fistulae has been demonstrated within the United States [3] and across several other countries [4]. Grafts predominate in most areas of the United States [3], even though they have generally been found to exhibit lower survival and higher complication rates than fistulae [5, 6]. The observed variation in the use of grafts and fistulae cannot be fully explained by patient case-mix attributes that impact vascular access selection, such as age, diabetes, and peripheral vascular disease [3]. The observed variation in vascular access practice patterns suggests opportunities for quality improvement if optimal practices can be defined. However, it is unknown if the observed variation represents local optimization of practice or a large-scale opportunity for improvement.

This study investigated the variation in vascular access preferences and practices across the United States and the association between access preferences and outcomes. Specifically, we sought to test the hypothesis that the preferred form of access placement in a dialysis facility yields superior longevity of access. The study was performed as part of the Dialysis Outcomes and Practice Patterns Study (DOPPS), a large, prospective, observational study of hemodialysis facilities and patients.

METHODS

The DOPPS sampling plan and study methods have been described at length elsewhere [7]. The current study was confined to the United States. Patient-level data were obtained from a national sample of 133 hemodialysis facilities in which 20 to 40 patients (an average of 30)

were randomly selected from a census of adult chronic hemodialysis patients (age >17 years). Study patients who departed from a facility were periodically replaced with patients who started hemodialysis treatment at the facility. The observation period of the study extended from June 1996 through October 1999.

Longitudinal data were collected for each study patient using a standardized chart abstraction procedure performed by a facility-based coordinator at each dialysis facility. The data collected for each patient included demographic characteristics, comorbid conditions, and vascular access events. At study enrollment, the current access type and the number, type, and location of prior accesses were recorded. All subsequent vascular access events (such as, thrombosis) and procedures (for example, salvage, revisions, new access creation) were recorded. In addition, the medical director and nurse manager at each participating facility completed a written questionnaire about local practice patterns, including vascular access preferences and practices. The vascular access section was part of a larger questionnaire that was field tested on a large group of nephrologists and other dialysis professionals during the development phase. Because the study questionnaire represented only a subset of the larger questionnaire, it wasn't feasible to test it separately or to compare it to some external standard.

Descriptive statistics were used to summarize vascular access preferences expressed by the medical director and the nurse manager and by actual practice within each facility. Logistic regression was used to model the probability of graft placement relative to fistula placement. Independent variables included age, sex, diabetes, body mass index, peripheral vascular disease, and vascular access preferences of the medical director at each dialysis facility. For permanent accesses that were created during the study ($N = 2{,}729$), Cox regression was used to model time from creation to first vascular access failure. Initial vascular access failure was defined as the first thrombosis, access salvage procedure, or creation of a new access. Accesses or fistulae that never matured or were never cannulated were classified as failures. Patients receiving dialysis via a catheter (including cuffed catheters) were excluded from the multivariate analyses. Models were adjusted for age, sex, new onset of end-stage renal disease (ESRD), diabetes mellitus as the cause of ESRD, and peripheral vascular disease. No adjustments were made for the presence of a vascular access monitoring program. The major contrast of interest for the study was the comparison of graft versus fistula survival by vascular access preference at the facility level. For all models, the variance estimates accounted for clustering of observations at the facility level.

Table 1. Permanent vascular access type preferences expressed by medical directors and nurse managers of DOPPS dialysis facilities

Question and responses	Medical director %	Nurse manager %
In general, what is the preferred type of permanent vascular access for patients who start dialysis in your unit?		
Native AV fistula	79	59
Synthetic graft	21	38
Other	1	3
In general, what is the preferred type of permanent vascular access for patients who start dialysis in your unit without a permanent vascular access in place?		
Native AV fistula	62	50
Synthetic graft	29	40
Other	9	10

Based on responses from 132 medical directors and 147 nurse managers.

RESULTS

Table 1 describes the vascular access preferences of the medical directors and nurse managers for new dialysis patients in general and for new patients who lack a permanent access. The majority of respondents expressed a preference for native fistulae. However, a sizable minority of providers (that is, physicians and nurses), ranging from 21% to 40%, preferred grafts.

The medical directors were asked to indicate their level of agreement with several statements concerning vascular access practices (Table 2). Respondents generally agreed that grafts were inferior to fistulae because of higher rates of infection and failure. When asked about the reasons that grafts may be superior to fistulae, respondents generally disagreed that grafts mature faster, but agreed that they are easier to needle. Respondents were divided when asked if they thought that tunneled, cuffed dialysis catheters ("PermCaths") were an excellent approach for providing dialysis until maturation of a permanent access. However, opinions were very positive toward uncuffed temporary catheters. A minority of providers embraced either of two alternate strategies posed for permanent access placement in patients who start hemodialysis without vascular access (first two questions).

Figure 1 displays the distribution of graft use at the facility level. The median penetration of grafts within dialysis facilities was 47% among all prevalent patients and 73% among prevalent patients who had a permanent vascular access (that is, a graft or fistula only, excluding patients who received dialysis via a catheter). Graft use within facilities ranged from 0% to 87% of all prevalent patients, including those using catheters. The large variability in the type of vascular access among dialysis facilities displayed a striking geographic pattern. Figure 2 shows the unadjusted percentage of graft use in each region as well as the odds ratio (AOR) of graft use,

Table 2. Summarized opinions of medical directors concerning type of vascular access

Question	Agree %	Disagree %
For new ESRD patients who present without any vascular access, we prefer to place a synthetic graft for use as soon as possible.	27	56
For new ESRD patients who present without any vascular access, we prefer to place a native AV fistula and perform dialysis with a temporary catheter or Permcath while the fistula matures.	13	74
In our unit, temporary vascular catheters are an excellent, low-risk technique for hemodialysis vascular access until a more permanent access can be created.	83	8
In our unit, PermCaths are an excellent vascular access until a more permanent access can be created.	41	40
In our unit, synthetic vascular access grafts are superior to native AV fistulae because they are easier to needle.	49	23
In our unit, synthetic vascular access grafts are superior to native AV fistulae because they mature sooner.	24	52
In our unit, synthetic grafts are inferior to native AV fistulae because they fail more often.	85	6
In our unit, synthetic grafts are inferior to native AV fistulae because they are more prone to infection.	71	8

The "agree" category includes "strongly agree" and "agree" responses. The "disagree" category includes "strongly disagree" and "disagree" responses. Neutral responses are not shown.

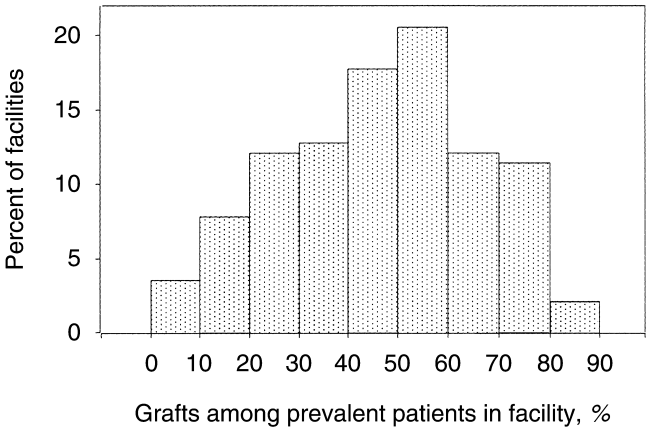

Fig. 1. Distribution of DOPPS dialysis facilities by percentage graft use among all prevalent patients.

adjusted for age, sex, diabetes, and peripheral vascular disease. Graft use was particularly high in the south-central states (82%, AOR 1.97) and low in the New England states (51%, AOR 0.38).

The type of vascular access in use by individual patients was strongly associated with the expressed access preferences of the medical director and nurse manager of the patient's dialysis center. Table 3 shows a series of logistic models that predict graft use. The probability that an individual patient had a graft was strongly and significantly associated with provider preference for grafts, as expressed several ways. In general, patients were more than twice as likely to have grafts than fistulae in facilities where the physician or nurse preferred grafts over fistulae (AOR=2.3, $P < 0.01$, reference group = facilities that did not prefer grafts), suggesting that facility provider preferences influence the type of access placement.

Access patency was assessed as the time to initial failure of all permanent accesses observed from first use during the study. Overall, the risk of access failure was higher for grafts than fistulae (RR 1.33, $P < 0.0001$). The risk of access failure was compared by facility preference, as expressed by provider preference as well as actual practice (Table 4). Actual practice was defined by categorizing facilities according to whether the use of grafts in prevalent patients was above or below the 46.8% overall facility median. The percentage of grafts that failed at one year was comparable in both facility types (63% vs. 61%, $P = 0.31$). Fistula failure tended to be more frequent in facilities with low graft use (one-year failure rate of 47% in facilities that preferred grafts vs. 54% in facilities that preferred fistulae, $P = 0.08$). The adjusted relative risk of graft versus fistula failure was not better in facilities that used more grafts (RR 1.57) as compared with facilities that used fewer grafts (RR 1.19). Analyses were not adjusted for the presence or absence of a vascular access monitoring program at the facility.

Access failure was also examined according to the stated preferences of the facility medical director and nurse manager (Table 4). The absolute graft failure rate was lower in facilities where either the medical director or the nurse manager stated a preference for grafts. However, the relative risk of graft versus fistula failure did not differ by the stated preference of the medical director (1.39 in both groups). In contrast, the relative risk of graft versus fistula failure was lower in facilities in which the nurse manager stated a preference for grafts than in facilities in which the nurse manager indicated a preference for fistulae (1.18 vs. 1.44).

DISCUSSION

Large variation exists in graft use across dialysis facilities (Fig. 1), displaying a geographic pattern within the United States (Fig. 2). Practice variation provides an opportunity to discover whether a specific practice is associated with a desired outcome. If an optimal practice can be established, then the observed deviation from that

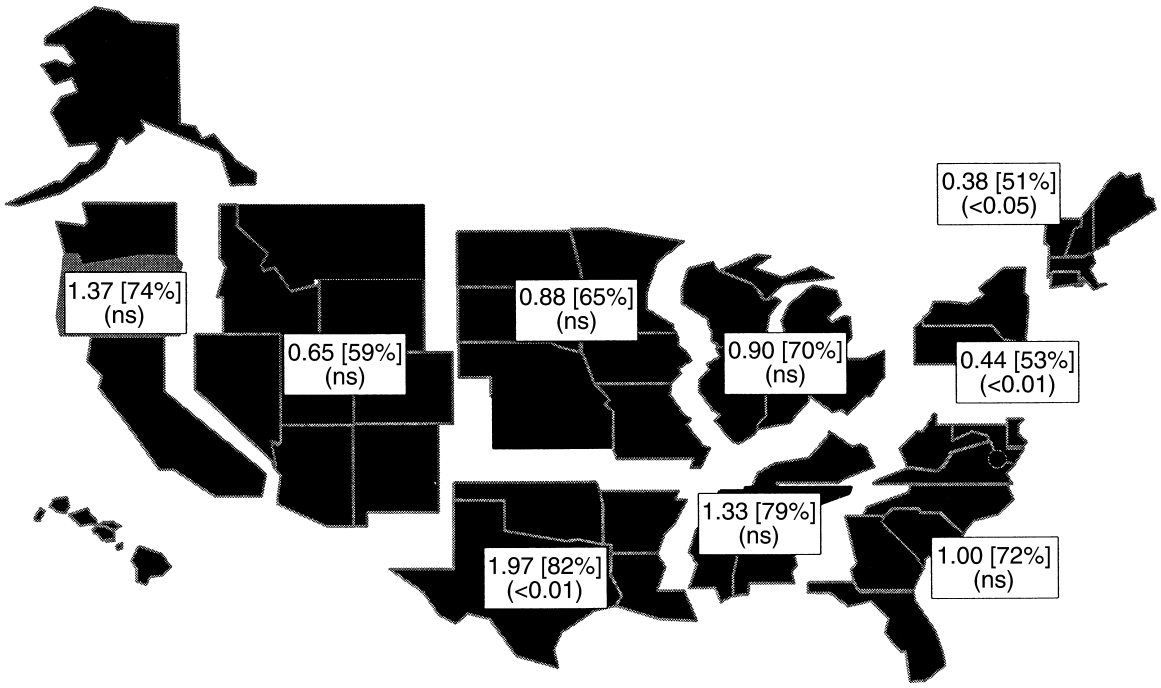

Fig. 2. Geographic distribution of graft use in the United States among prevalent patients with a permanent vascular access. The adjusted odds ratio (graft vs. fistula), percentage graft use, and *P* value are listed for each region. The odds ratio is adjusted for age, sex, diabetes, and peripheral vascular disease. The reference group was the overall national average, assigned an AOR of 1.0.

Table 3. Adjusted odds ratios of patient having a graft (vs. fistula) by stated preference of the facility medical director or nurse manager

Measure of vascular access preference[a]	% Graft use[b]		AOR[c] (*95% CI*)	*P* value
	Yes	No		
Medical director prefers grafts generally	83	68	2.23 (1.34, 3.72)	0.002
Nurse manager prefers grafts generally	80	63	2.36 (1.72, 3.23)	<0.0001
Medical director prefers grafts in patients new to the dialysis facility who lack permanent access	84	66	2.76 (1.90, 4.03)	<0.0001
Nurse manager prefers grafts in new patients who lack permanent access	80	62	2.50 (1.84, 3.40)	<0.0001
Medical director prefers grafts for patients with newly developed ESRD who lack perm access	83	67	2.32 (1.60, 3.36)	<0.0001
Medical director believes grafts superior because easier to needle than F	84	69	2.29 (1.23, 4.26)	0.009
Medical director believes grafts superior because they mature sooner than F	81	68	1.91 (1.22, 2.99)	0.005

[a] Each response run as a separate model. For each model, facilities in which provider expressed the stated opinion are compared to facilities in which provider did not express the opinion.

[b] Percentage of patients with a graft in facilities in which respondent answered "Yes" or "No" to the declaration in first column. All patients, including those using catheters, were included in this data.

[c] AOR, adjusted (for age, sex, diabetes, PVD, incident ESRD status) odds ratio of an individual patient receiving a graft vs. a fistula. Patients using catheters were not included.

practice offers potential opportunities for improvement. For vascular access type, our study and others strongly suggest that, on average, the practice of placing fistulae is associated with the longest vascular access survival [5, 6] and that an important opportunity exists to improve vascular access outcomes by promoting a shift toward creation of fistulae. However, it is possible that grafts could provide superior outcomes in some facilities. If so, the optimal vascular access type would depend on local conditions such as training and skill of staff (such as, surgeons, dialysis nursing staff) or unmeasured patient characteristics. Accordingly, we sought to characterize attitudes and actual practices concerning vascular access type. We then asked whether graft patency was superior

Table 4. Absolute and relative risks of vascular access failure by type, actual practice at dialysis facility, and expressed preference of facility providers

Nature of vascular access preference	% Failed at one year		RR (G vs. F)[b]	*P* value
	Graft	Fistula		
A. Graft use > median[a]	63	47	1.57	<0.001
B. Graft use < median	61	54	1.19	0.03
P value, A vs. B	0.31	0.08		
C. MD prefers graft	58	46	1.39	0.053
D. MD prefers fistula	64	52	1.39	<0.001
P value, C vs. D	0.04	0.46		
E. NM prefers graft	59	53	1.18	0.127
F. NM prefers fistula	64	51	1.44	<0.001
P value, E vs. F	0.06	0.41		

Abbreviations are: MD, medical director; NM, nurse manager.
[a] Median facility graft use = 46.8%
[b] Relative risk of failure of graft (G) compared to fistula (F), adjusted for age, sex, diabetes, peripheral vascular disease, and incident ESRD status

in facilities with a preference for grafts. In other words, we tested the hypothesis that a local preference for grafts represented a rational response to local conditions.

As noted, a variation among facility medical directors and nurse managers was found in their vascular access preferences (Tables 1 and 2). Providers did not express a uniformly preferred strategy for vascular access placement in new patients. We suspect that decisions are based on program preferences and individual patient characteristics, making it difficult to select an overall strategy on a survey. The majority of providers stated a preference for fistulae although a substantial minority preferred grafts. Grafts were preferred for reasons such as easy needling and, to a far lesser extent, faster maturation. Physicians were more likely than nurses to prefer fistulae, in agreement with a prior study [8]. Furthermore, the stated preferences of medical directors and nurse managers strongly and significantly predicted graft use (Table 3). Although it is possible that dialysis personnel come to prefer the type of access preferentially placed by local surgeons, it seems more likely that they actually influence the type of access created by the surgeon. If the physicians and nurses in a dialysis facility prefer a certain type of vascular access, then that type is more likely to be created. This dynamic bodes well if efforts are made to change the preferred type of access in dialysis facilities.

It is notable that grafts are placed more often than fistulae, even though a majority of dialysis providers expressed a preference for fistulae. However, graft use varied widely by facility (Fig. 1). Furthermore, geographic differences in graft versus fistula use were found, similar to the pattern described by Hirth et al (Fig. 2) [3]. Fistulae use is much higher in Europe than in the United States [4, 9]. The relatively low prevalence of fistulae in the United States has been attributed to unfavorable patient characteristics such as diabetes, peripheral vascular disease, and older age of patients. However, the observed variation persists after adjustment for these patient characteristics [4]. Furthermore, measured case-mix differences do not explain the large variation in graft versus fistula use across dialysis facilities and geographic regions within the United States. These considerations indicate that it should be possible to increase the number of hemodialysis patients who receive a native fistula. It follows that fistula use should be promoted unless it can be shown that graft survival is superior in certain facilities.

The inferior overall survival rate for grafts relative to fistulae has been demonstrated previously [5, 6], although the opposite results have been reported at selected, single dialysis centers [10]. In this study, we found that grafts were inferior to fistulae in terms of survival, even in facilities with a preference for grafts (Table 4). Thus, it appears that the preference for grafts is not generally a rational decision based on longevity of access. Other valid reasons may exist to prefer grafts, such as ease and speed of creation, ease of needling, assurance of high blood flow, and avoidance of prolonged dialysis using catheters. However, it is questionable whether such advantages outweigh the disadvantages of shorter patency and higher rates of infection. It is notable that graft outcomes were somewhat less adverse in facilities where the nurse manager expressed a preference for grafts, indicating that local factors may influence outcomes to an extent. However, graft survival was still inferior to fistula survival in all cases. Although analyses were not adjusted for the presence or absence of a vascular access monitoring program at the facility, confounding is unlikely as there was no evidence of an association between access monitoring programs and vascular access preferences.

This study reflects practices that were in effect during the period of release of the NKF-DOQI practice guidelines [11]. Many factors probably contribute to facility-level decisions to favor grafts over fistulae, but there is no evidence that graft outcomes are superior in facilities that prefer grafts to fistulae. While fistula creation may not be feasible in some situations, the variation across facilities and regions suggests exaggerated avoidance of fistulae. Local reconsideration of vascular access practices could lead to creation of more fistulae and longer access survival.

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REFERENCES

1. Feldman HI, Held PJ, Hutchinson JT, *et al*: Hemodialysis vascular access morbidity in the United States. *Kidney Int* 43:1091–1096, 1993

2. U.S. Renal Data System: *USRDS 1997 Annual Data Report*. Bethesda, MD, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 1997
3. Hirth RA, Turenne MN, Woods JD, *et al*: Predictors of type of vascular access in hemodialysis patients. *JAMA* 276:1303–1308, 1995
4. Pisoni RL, Young EW, Dykstra DM, *et al*: Vascular access use in Europe and the United States: Results from the DOPPS. *Kidney Int* 61:305–316, 2002
5. Churchill DN, Taylor DW, Cook RJ, *et al*: Canadian hemodialysis morbidity study. *Am J Kidney Dis* 19:214–234, 1992
6. Woods JD, Turenne MN, Strawderman RL, *et al*: Vascular access survival among incident hemodialysis patients in the United States. *Am J Kidney Dis* 30:50–57, 1997
7. Young EW, Goodkin DA, Mapes DL, *et al*: The Dialysis Outcomes and Practice Patterns Study: An international hemodialysis study. *Kidney Int* 57(Suppl 74):S74–S81, 2000
8. Bay WH, Van Cleef S, Owens M: The hemodialysis access: Preferences and concerns of patients, dialysis nurses and technicians, and physicians. *Am J Nephrol* 18:379–383, 1998
9. Burger H, Kootstra G, de Charro F, Leffers P: A survey of vascular access for haemodialysis in The Netherlands. *Nephrol Dial Transplant* 6:5–10, 1991
10. Palder SB, Kirkman RL, Whittemore AD, *et al*: Vascular access for hemodialysis: Patency rates and results of revision. *Ann Surg* 202:235–239, 1985
11. National Kidney Foundation-Dialysis Outcomes Quality Initiative: NKF-DOQI clinical practice guidelines for vascular access. *Am J Kidney Dis* 30(Suppl 3):S150–S191, 1997